Turbulence Auto-Pirep System

TAPS

I-CNS Conference, May 2003

Dr. Paul A. Robinson
President, AeroTech
paulrobinson@atr-usa.com

Improved Turbulence Situational Awareness

Developed as part of the Turbulence Element of NASA's Aviation Safety Program

- ✓ **Complementary technology**
- ✓ **Non flight critical software**

The Turbulence Problem

Current turbulence pireps

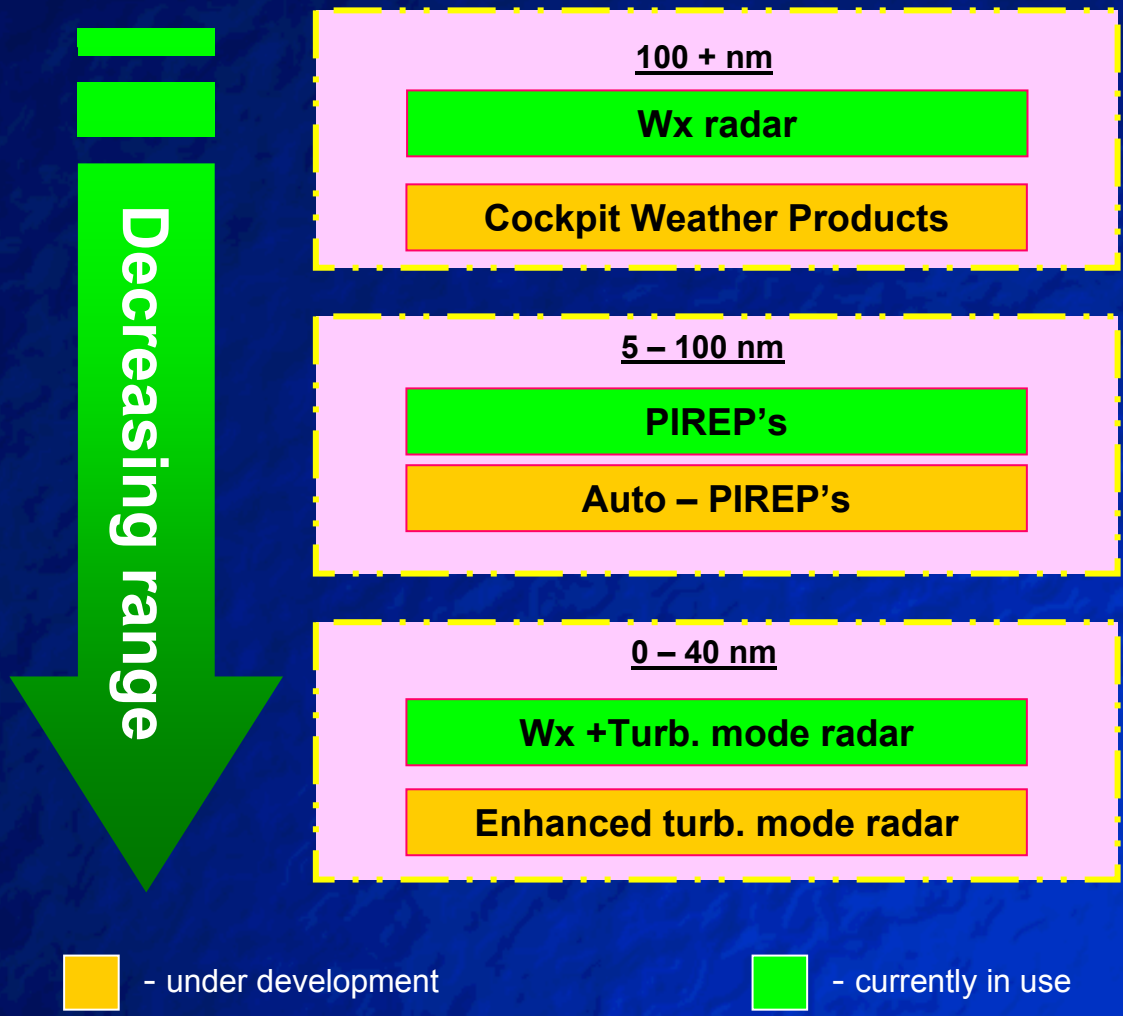
- inconsistent
- late
- subjective
- only “seen” by ATC

Economic impact of turbulence encounters

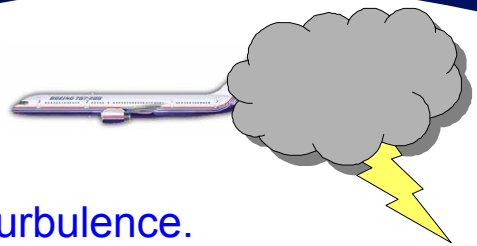
- flight attendant injuries
- passenger injuries
- operational inefficiencies
- NAS inefficiencies

Estimated Costs > $100M / year

Seamless Hierarchy of Airborne Turbulence Products

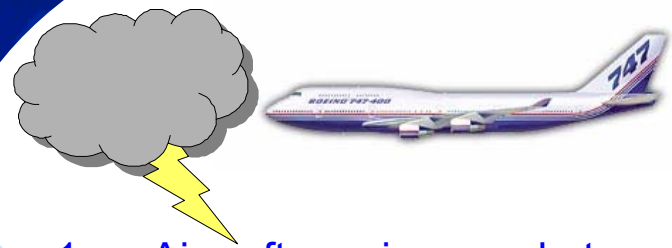


TAPS Overview



1. Aircraft hits turbulence.
2. If loads are above a threshold then algorithm generates and broadcasts an alert packet:
   - position & time
   - load
   - aircraft parameters from databus

communications infrastructure



1. Aircraft receives packet.
2. Scales hazard to type & configuration.
3. Displays to flight crew (if at or above threshold).

1. Packet received on ground & stored in database.
2. Presented on map, scaled to pilot's aircraft (if at or above threshold).

Example Operational Scenario Today: Near Convection

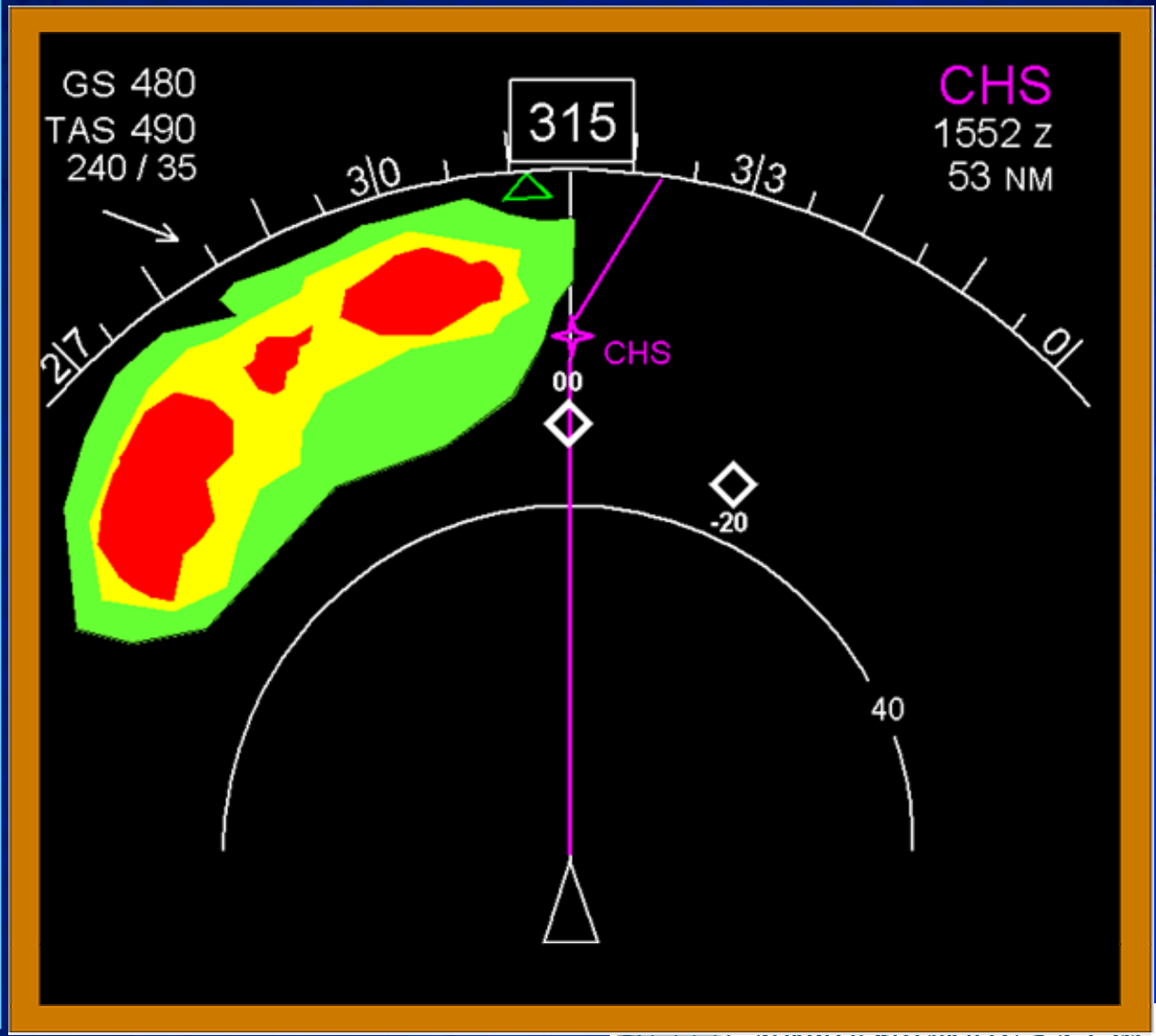
-Convection detected by onboard radar

- Other aircraft in general vicinity

- Turbulence reports received (voice)

-Turbulence awareness from PIREPS, ATC, AOC/dispatch

- *Situational awareness of turbulence limited*



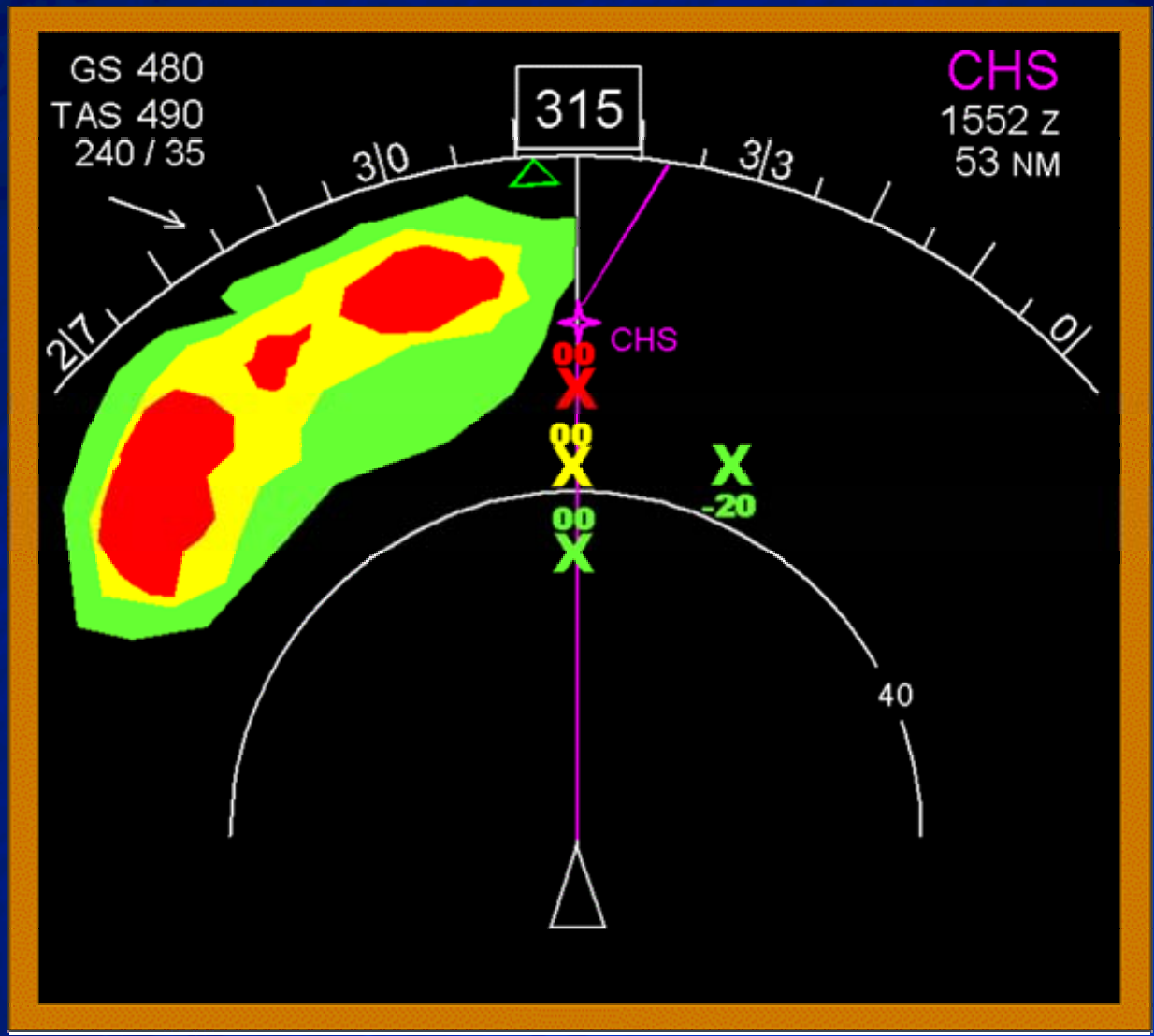
Example Scenario & *TAPS* display concept

- Data received from other aircraft is translated into a turbulence hazard for receiving aircraft.

- Same aircraft may transmit several warnings.

- Hazard warning icons color- coded severe moderate light shown with relative altitude (100's of feet).

- Provides improved situational awareness of turbulence.



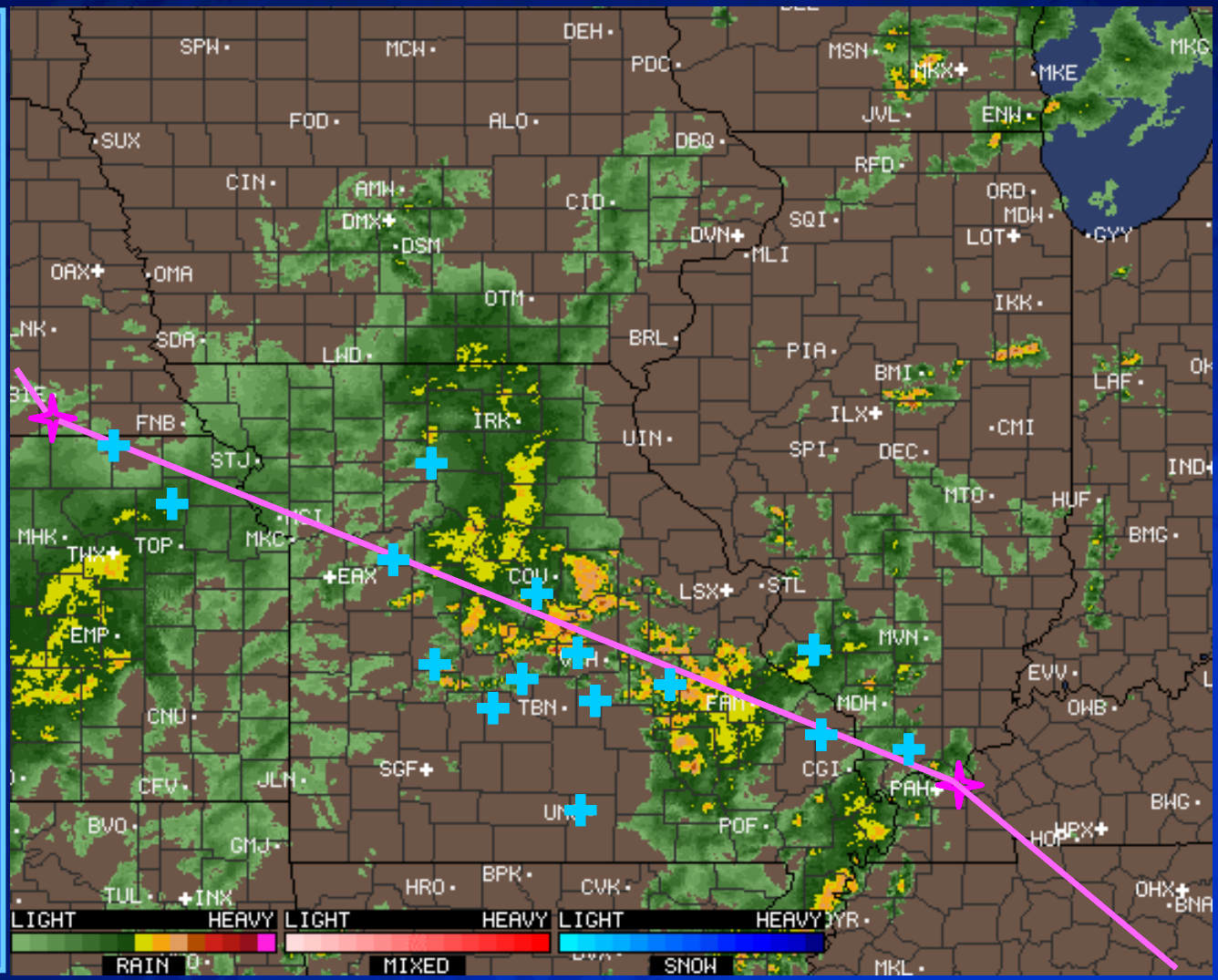
Example Operational Scenario Today : Preflight Dispatch

-Region of convection affecting planned flight path (purple line).

- Other aircraft on and around flight path (blue crosses)

- PIREPS relayed to dispatch/AOC/OCC

- *Situational awareness of turbulence limited*



Example Concept Scenario: Preflight Dispatch

-Region of convection affecting planned flight path (purple line).

- Specific aircraft type, weight, speed, and altitude

- Automated reports from other aircraft scaled to designated aircraft.

- *Situational awareness of turbulence improved*

Type: B 777-200
Weight: 575,000 – 600,000 lbs
Alt: FL 310
Speed: M 0.82

Example Concept Scenario: Preflight Dispatch

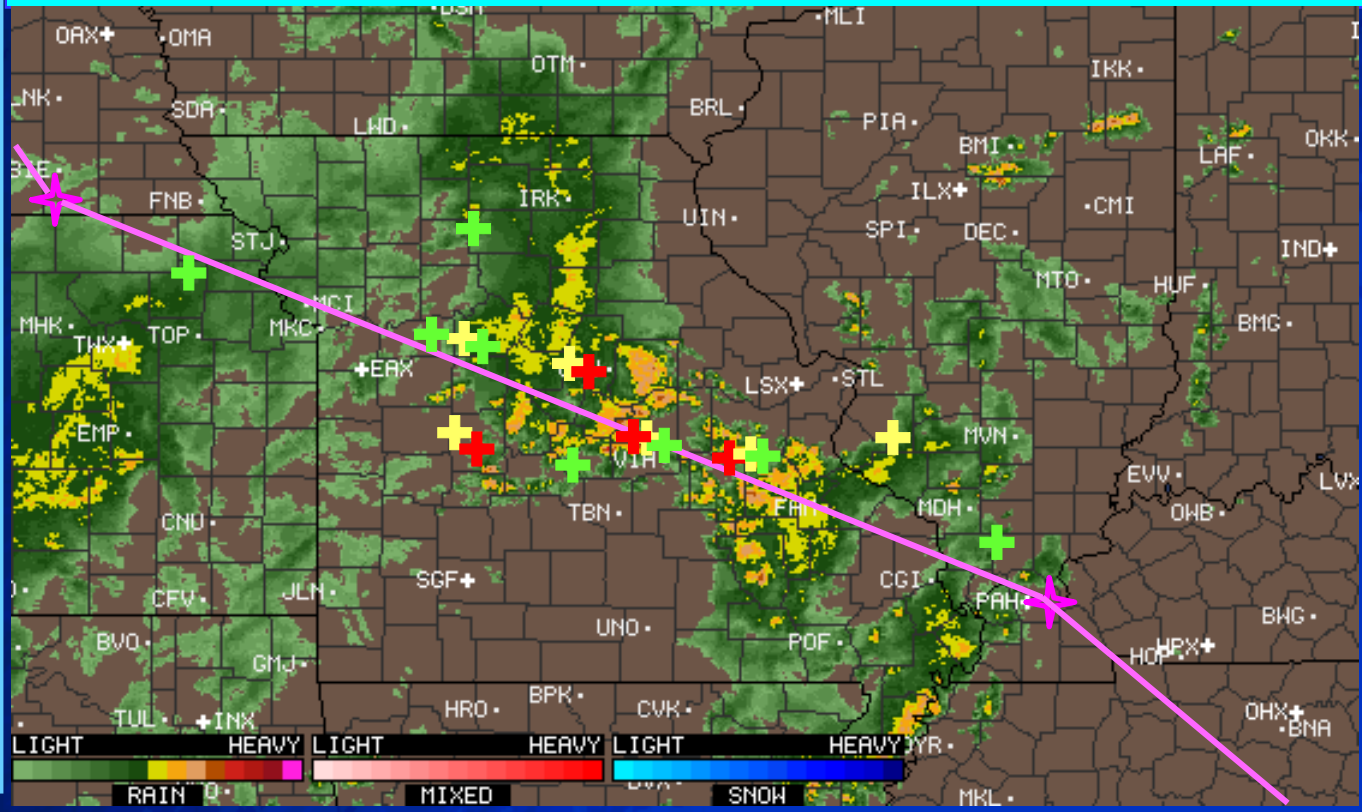
-Region of convection affecting planned flight path (purple line).

- Specific aircraft type, weight, speed, and altitude

- Automated reports from other aircraft scaled to designated aircraft.

- *Situational awareness of turbulence improved*

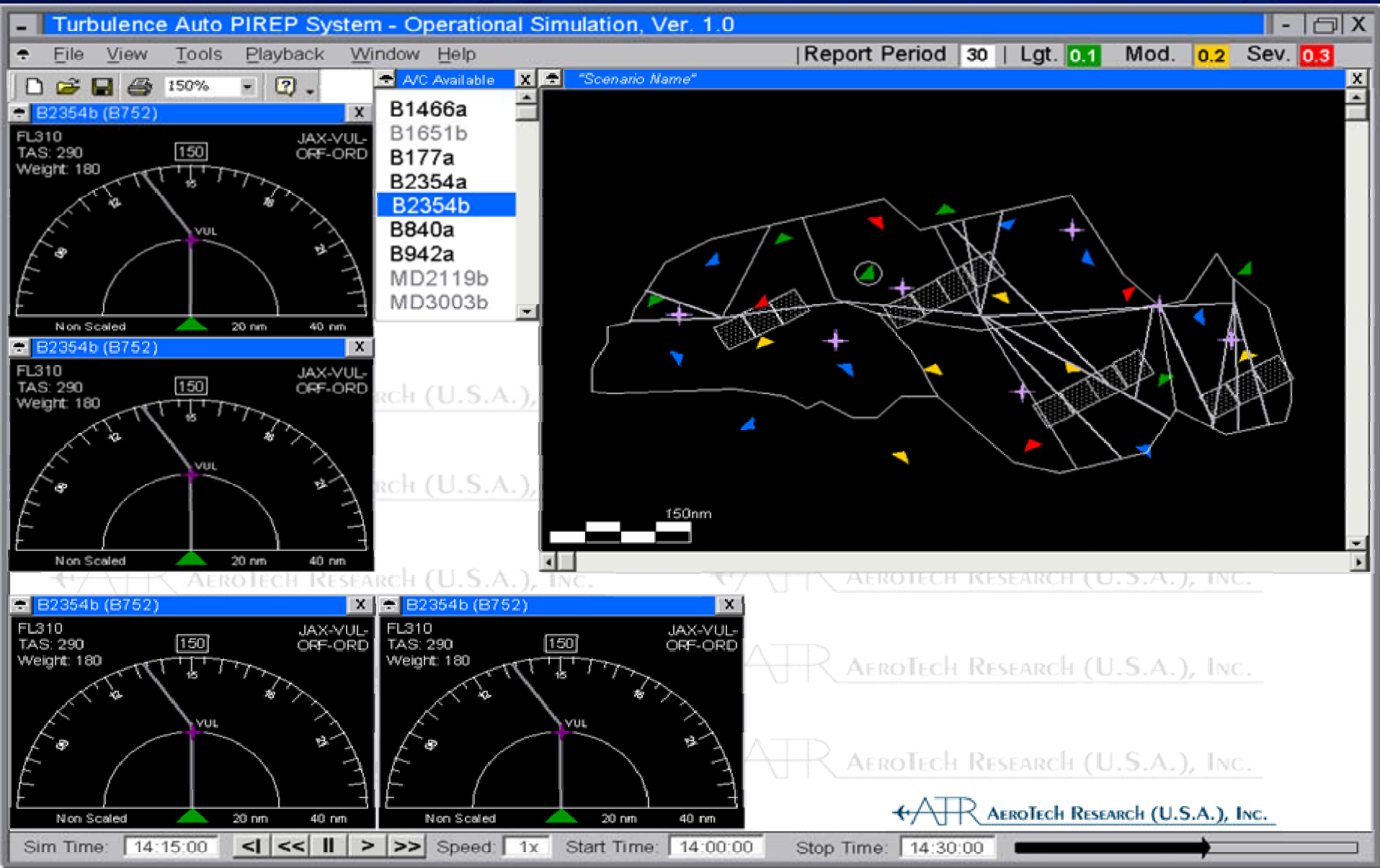
Type: B 737-800
Weight: 130,000 – 150,000 lbs
Alt: FL 260
Speed: M 0.76



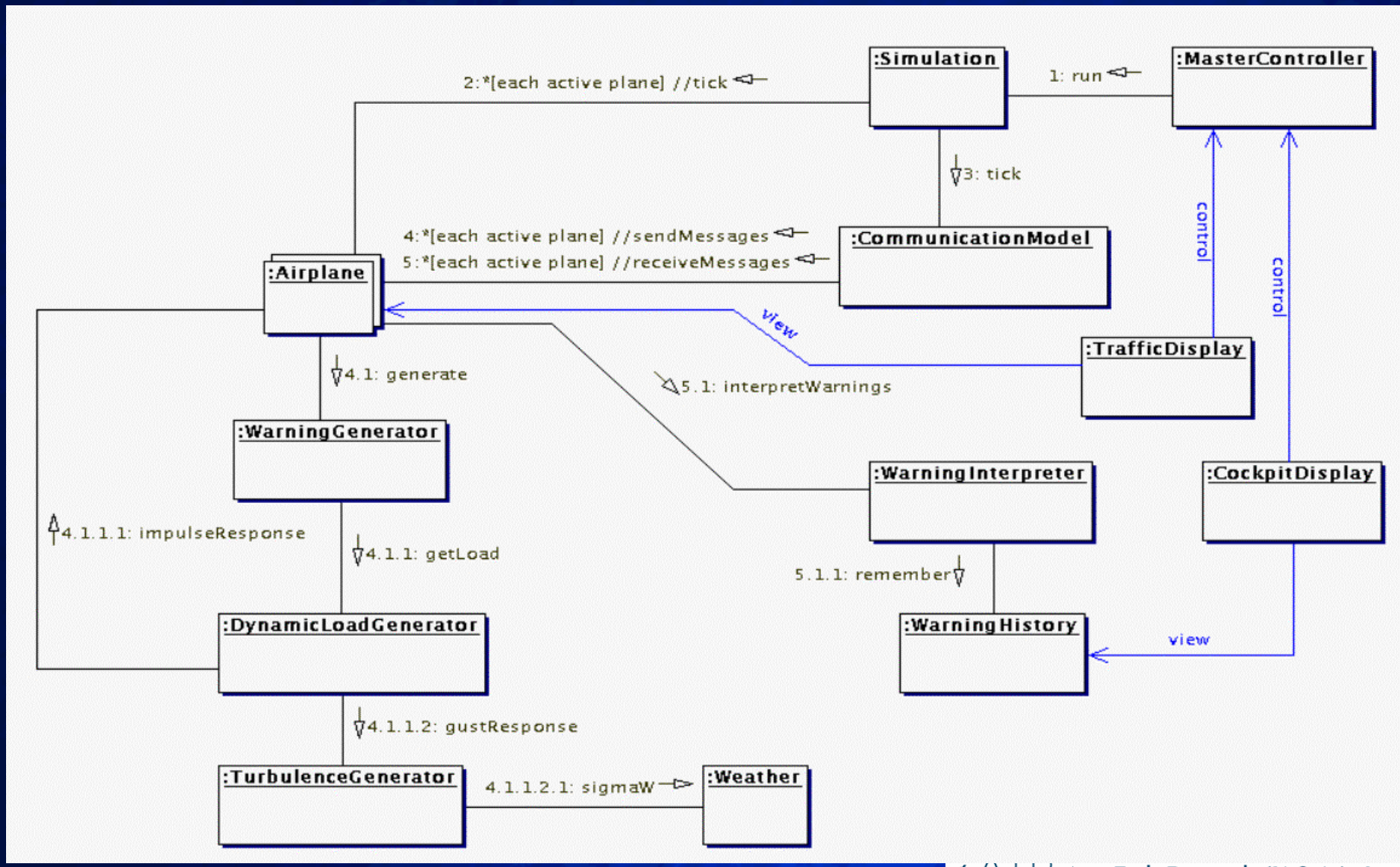
Beneficiaries of *TAPS*

- Pilots – corporate & Part 121
- Flight Attendants & Passengers
- Air Traffic Controllers
- Dispatchers
- Airlines

TAPS Operational Simulation



TAPS Operational Simulation



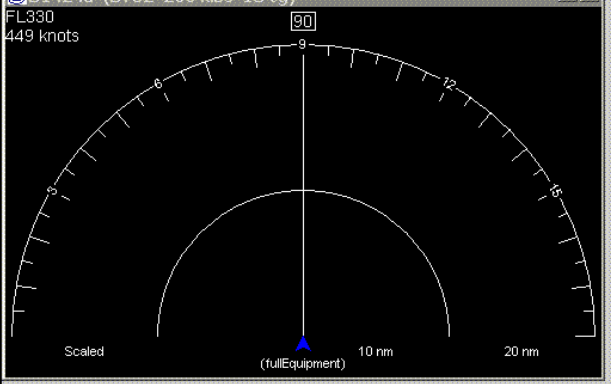
Unregistered HyperCam

System - Operational Simulation, Version 1-1-0

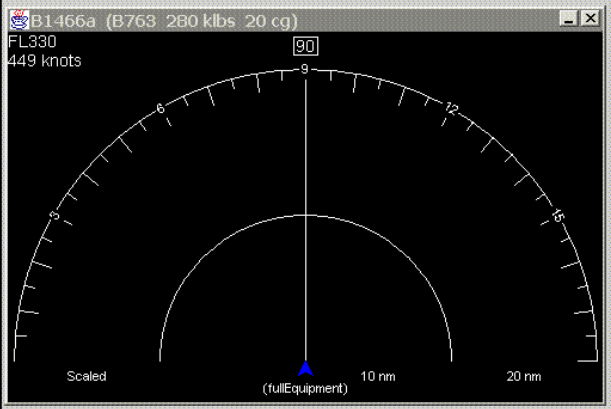
File View Playback Window Help

Background SigmaW: 0.0 Report Threshold: 0.1 Report Period: 30.0 Lgt: 0.17 Mod: 0.23 Sev: 0.28 Recenter-and-zoom Tool

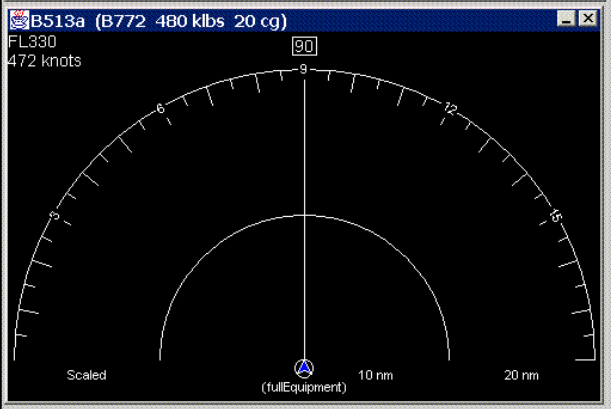
B1424a (B752 200 klbs 18 cg)



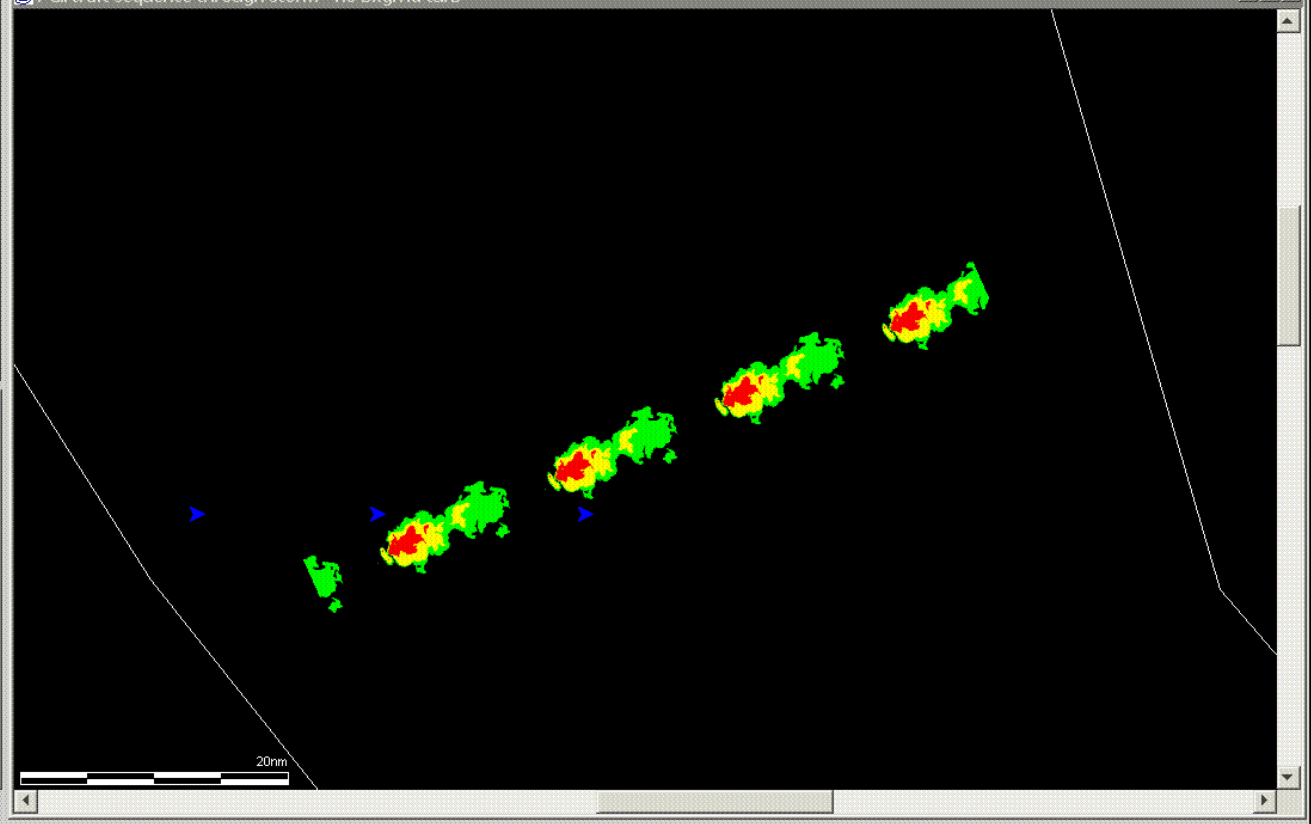
B1466a (B763 280 klbs 20 cg)



B513a (B772 480 klbs 20 cg)



7 aircraft sequence through storm - no bkgrnd turb



A/C Avail...

A455
B1424a
B1466a
B2354a
> **B513a**
B737t
MD1677

AeroTech Research (U.S.A.), Inc.

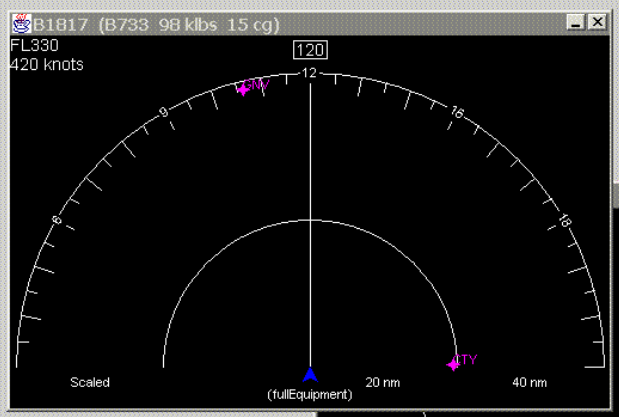
Sim Time: 14:05:01 Play the simulation Start Time: 14:00:00 Stop Time: 15:00:00 8%

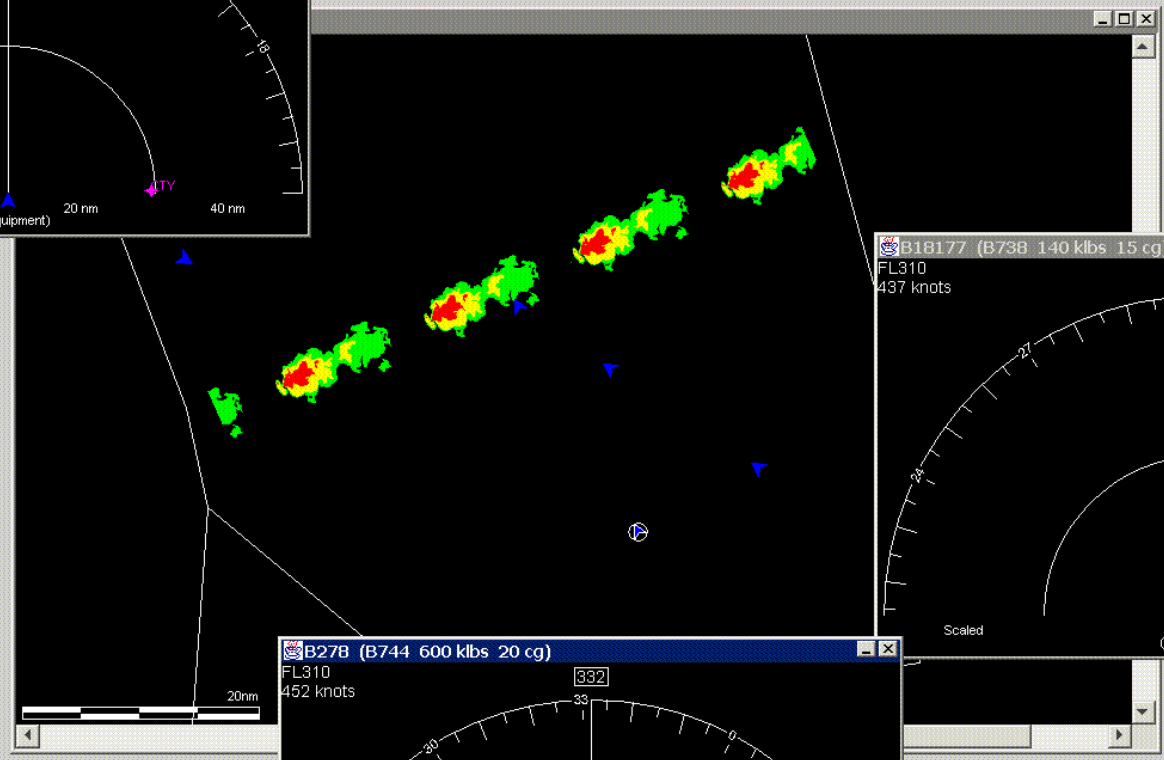
AeroTech Research (U.S.A.), Inc.

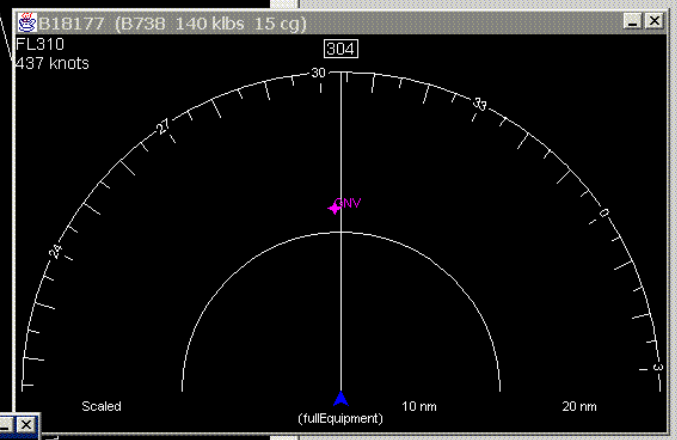
Unregistered HyperCam
System - Operational Simulation, Version 1-1-0

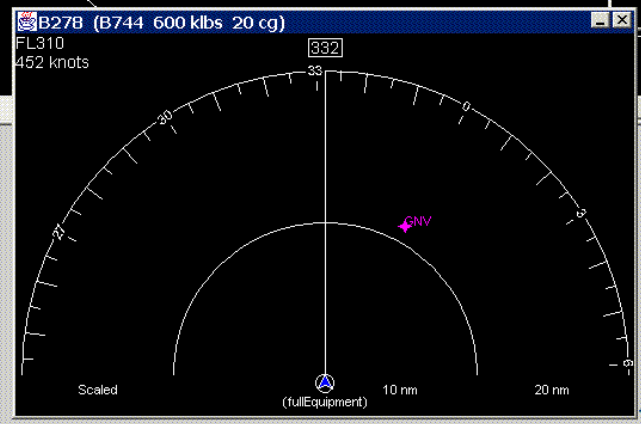
File View Playback Window Help

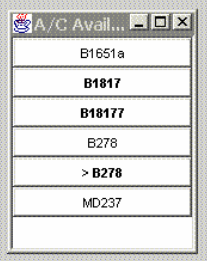
Report Period: 30.0 Lgt: 0.17 Mod: 0.23 Sev: 0.28 Recenter-and-zoom Tool











AeroTech Research (U.S.A.), Inc.

Sim Time: 14:06:34 5X Start Time: 14:00:00 Stop Time: 14:15:00 43%

AeroTech Research (U.S.A.), Inc.

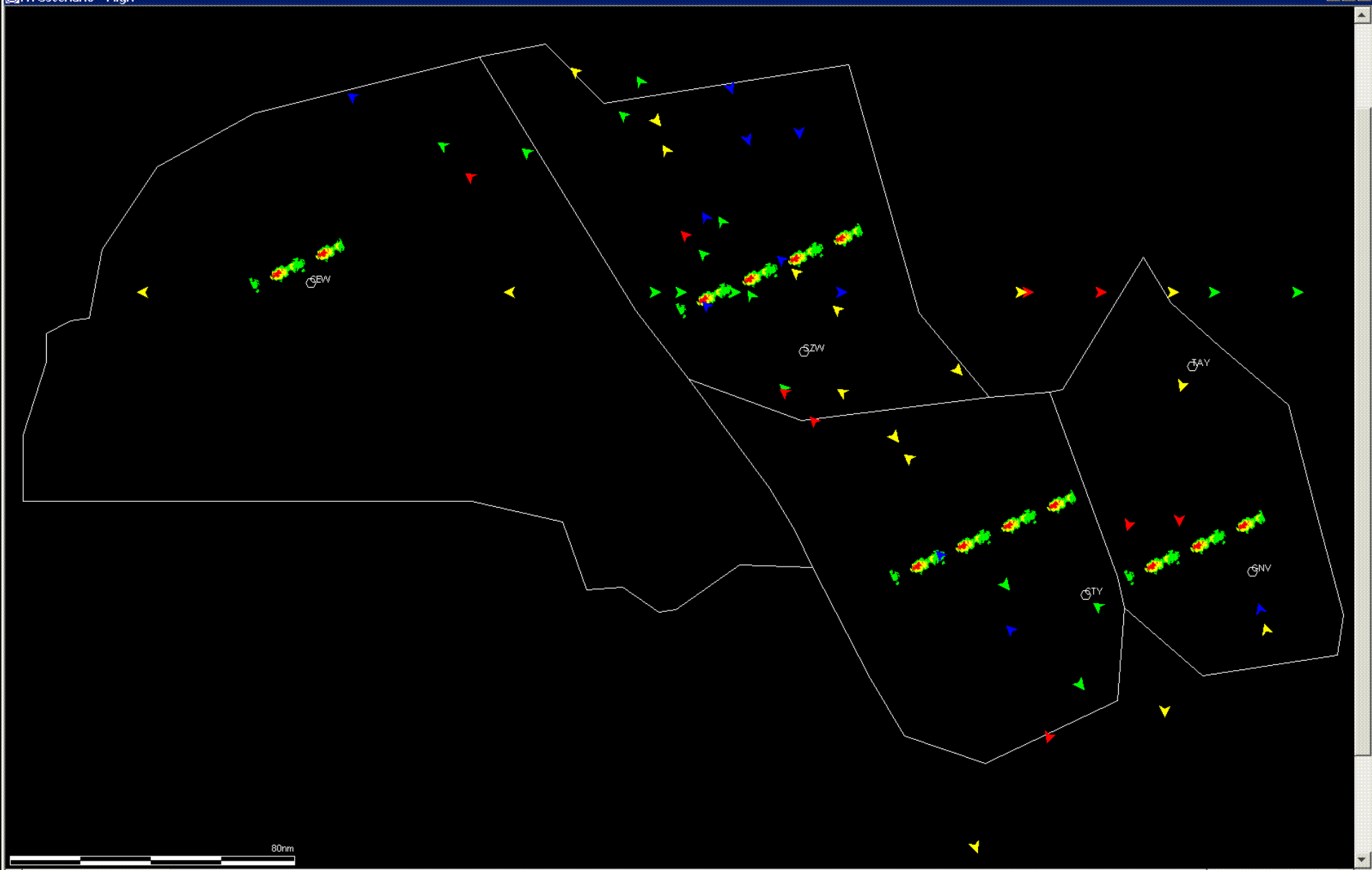
Unregistered HyperCam

System - Operational Simulation, Version 1-1-0

File View Playback Window Help

Background SigmaW: 4.0 Report Threshold: 0.1 Report Period: 30.0 Lgt: 0.17 Mod: 0.23 Sev: 0.28 Recenter-and-zoom Tool

ATCscenario - High



Sim Time: 21:49:26 7X Start Time: 21:00:00 Stop Time: 22:30:00 55%

Year 1: TAPS Groundstation Implementation

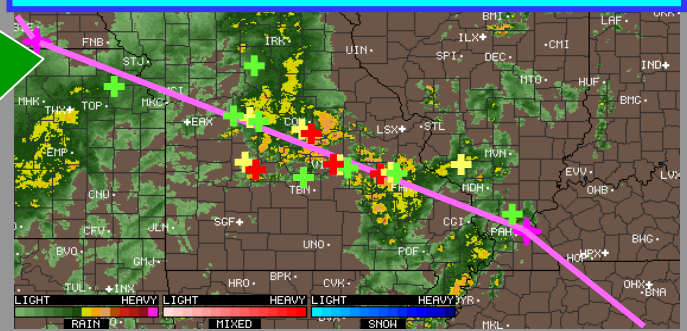
Reporting algorithms implemented on aircraft

Turbulence reports made to ground

Reports received and relayed to groundstation via network

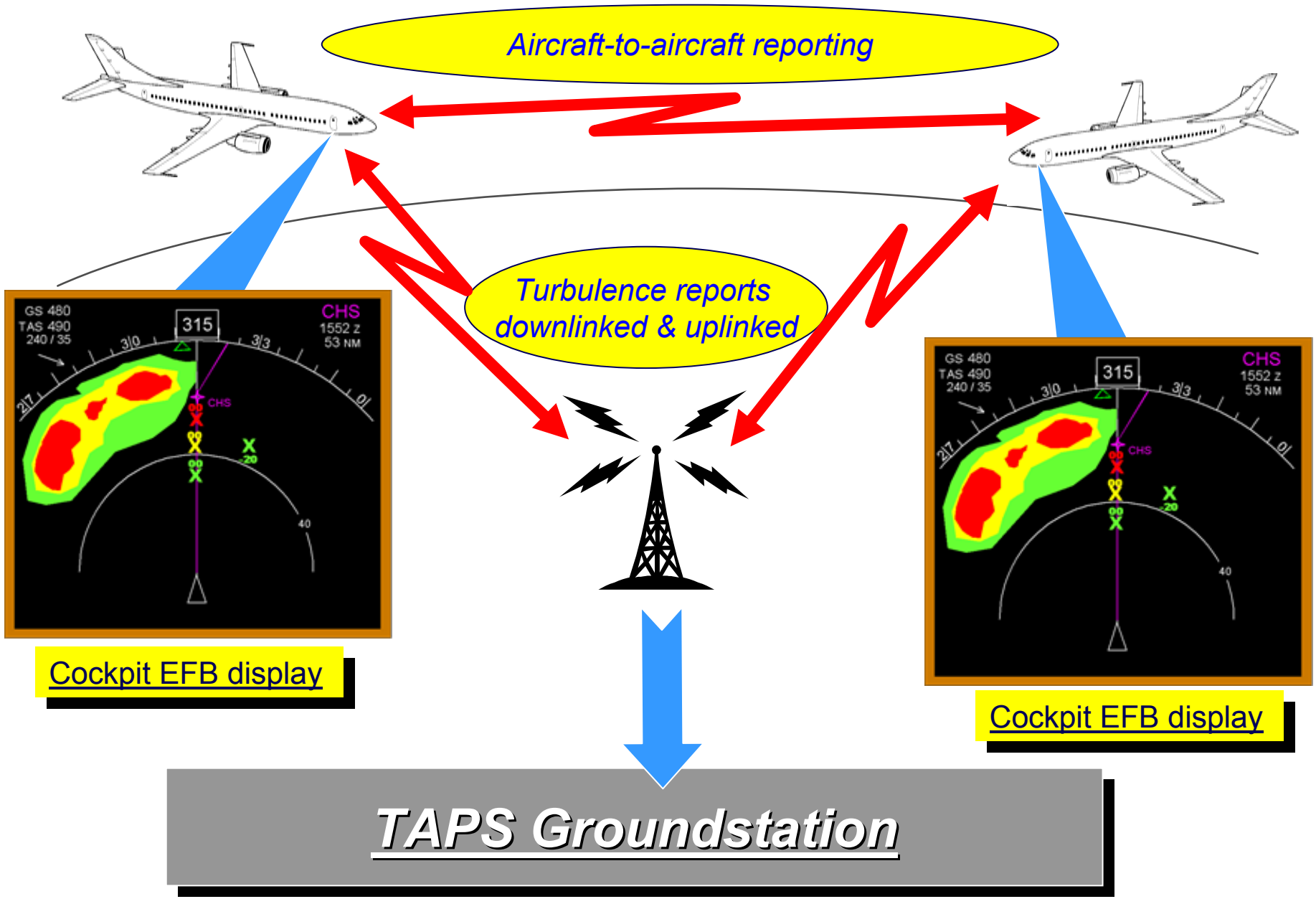
Scaling & interface

Type:	**B 737-800**
Weight:	**130,000 – 150,000 lbs**
Alt:	**FL 260**
Speed:	**M 0.76**

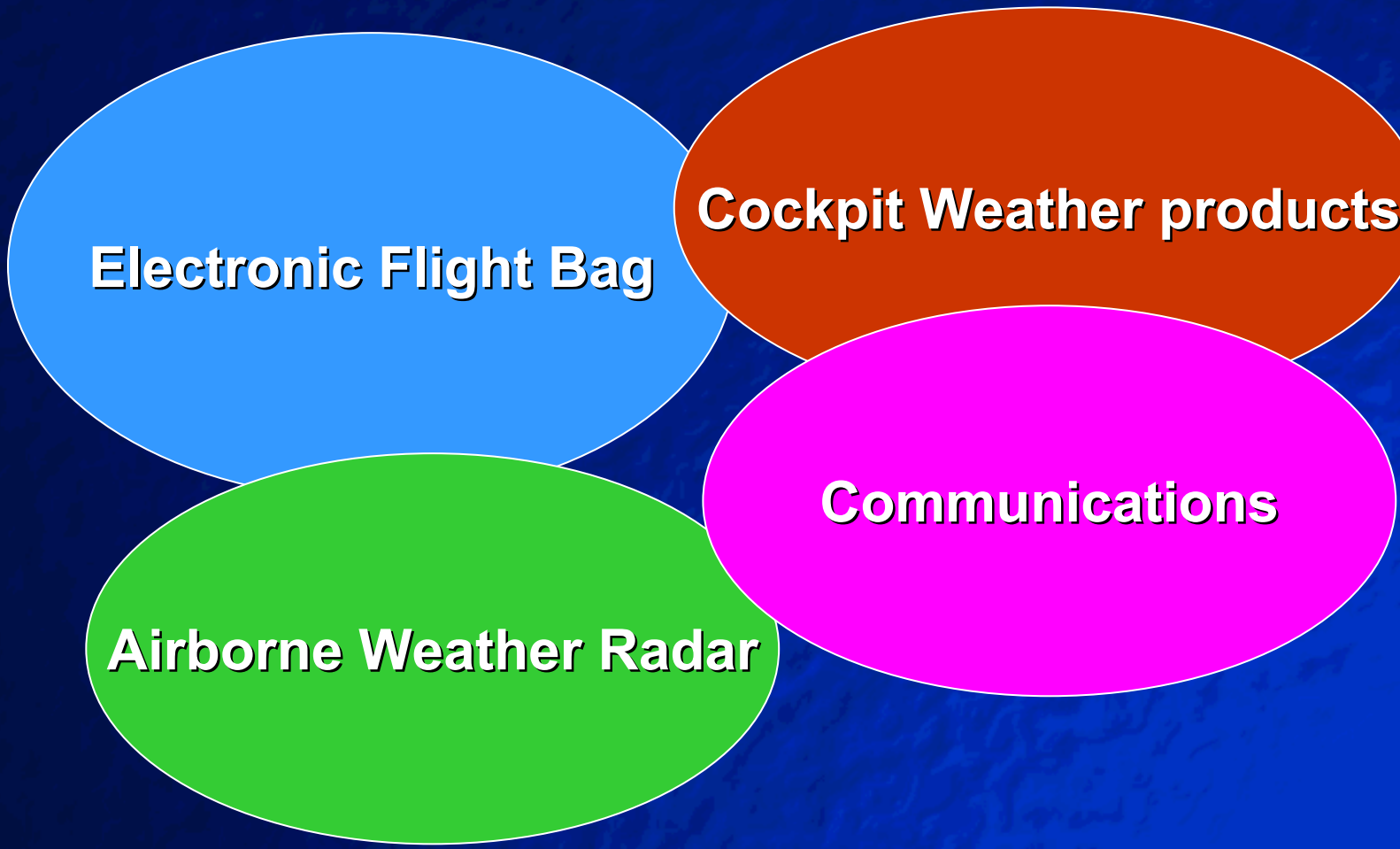


TAPS Groundstation

Years 2-3: TAPS Cockpit Implementation



Related Products – *Enabling Technologies?*



TAPS Development: Results to Date

- FY-02 flight test – single aircraft
  - Reporting logic test
  - Comms test – 0.52 sec roundtrip

NASA LaRC B-757 Research Aircraft

- Development of operational simulation for system studies.
- 1st Implementation group meeting held.

TAPS Development: 2003-2005

- FY-03 flight test – two aircraft flying in trail.
  - Real-time turbulence reports
  - Skyphone/Iridium communications
  - Turbulence hazard prediction on both aircraft.

NASA GRC Lear Jet Research Aircraft

NASA LaRC B-757 Research Aircraf

- Groundstation and cockpit display development.
- System requirements and CONOPS development.
- Further Implementation Group meetings to be held.
- FY-2005 flight evaluation.